Seasonal average, 1895–1916 (fig. 30).—The great snowfall of the exposed highlands, the local snow shadows and the relatively light snowfall of the coast show that the features apparent in the maps of individual seasons have sufficient repetition to be shown as usual phenomena. Only on the coldest part of the coast (Maine) does the heavy shore snowfall of the late winter make the total greater than that a short distance inland.

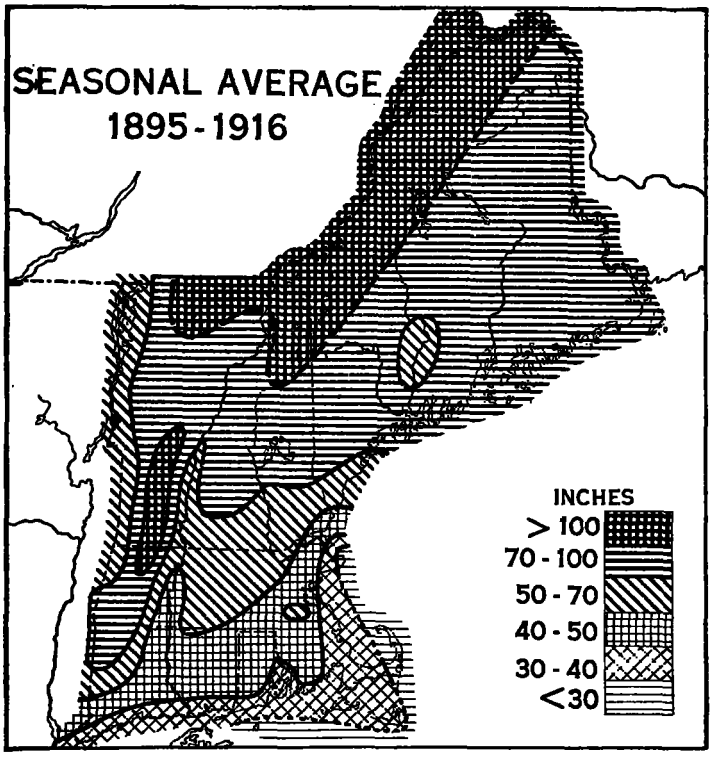

FIG. 30.—Mean seasonal snowfall, for 1895–1916. [Am. geogr. soc.]

SUMMARY.

Air temperature is probably the first factor in determining snowfall. The latitude and altitude differences in temperature cause the heaviest snowfall so far as controlled by temperature to be in the north and on the highlands. Similarly, the most snow tends to come in the coldest month, except in the north in winters colder than usual. Although January is as cold as February, the snow-bearing winds of February are the colder and so the snowier. The warmth of the coast is less favorable for snowfall than the coldness of the interior.

Without precipitation, however, there can be no snowfall. Precipitation is greatest on highlands near or facing bodies of water and near the paths of cyclone centers. The seasonal variations are small in amount.

Wind direction during precipitation is the third important factor controlling snowfall. Windward slopes of mountains and leeward shores tend to have the most precipitation. Combine the effects of these three factors, and the distribution of snowfall in New England may be explained. The highlands are the snowiest; for they are cold, moist, and windy. Particularly snowy are those slopes which are openly exposed to easterly or northeasterly winds or, as in the north, to the westerly winds from the Great Lakes. The intermontane valleys have less snowfall because of the higher temperature, less precipitation, and less exposure. In the coastal region there is plenty of precipitation, and open exposure, for the most part, so that the snowfall depends chiefly on the temperatures. Thus in early winter the snowfall is less than in late winter; in early winter the snowfall on the immediate coast is less than that inland, allowing for topographic influences; and in late winter the snowfall of the coast is the heavier. As New England is the focus of most of the cyclones which cross the United States or come up the east coast, there are chances for wide variations in their paths. On this account all parts of New England are crossed by numerous cyclones. As the strongest ones, however, pass south of New England or cross its southeastern portion, this section from time to time experiences extraordinary snowstorms, a great characteristic of the climate of New England.

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THE COLD SPRING OF 1917.

By PRESTON C. DAY, Climatologist and Chief of Division.

[Dated: Washington, D. C., July 3, 1917.]

Beginning about April 24, and continuing to the middle of May, a period of three weeks, cold weather for the season of the year persisted to an unusual degree in nearly all portions of the country. The daily temperatures for the period, as shown by figure 1, were almost continuously below the normal, and the mean for the 21 days was likewise below the normal at practically every Weather Bureau station in the United States. The deficiencies for the period ranged from about 3 degrees per day near all the border lines, to 9 degrees over the interior districts, reaching extreme values as great as 12 degrees per day at local points from southeastern Wyoming to central Ohio.

After a brief interval of about one week with temperatures generally, though not materially, above normal over most districts east of the Rocky Mountains, another period of cold set in about May 22 and continued with but few interruptions until the end of the second decade of June, a period of about four weeks. In duration, amount of the departure below the normal temperature, and at times in area covered, this second cold period exceeded that first mentioned. For this period the mean temperature was below the normal over all portions of the country save along the Gulf and South Atlantic coasts, and at a few points in the far Northwest. Over all the interior portions the weather for these four weeks was almost continuously cold, the mean temperature ranging 6 to 8 degrees below the normal, with individual short periods having temperatures 10 to 20 degrees or more, below. The departures from the normal temperature for this period as a whole, are shown by figure 2.

Considering the month of May in its entirety the temperature averaged below normal in every portion where full reporting stations of the Bureau are located, save in extreme northwest Montana where a single station showed an excess of but a few tenths of a degree. This exception is probably due to an inadequate record for the normal.

An examination of previous records for May since 1872, the earliest year yielding Weather Bureau observations from coast to coast, does not disclose another instance when the average temperature for that month was so universally below the normal. In other years the negative departures over local areas, in a few cases, have been equal to or slightly greater than those for May, 1917, but in no case has the area covered equaled that of the month under discussion.

Causes of the low temperatures.

An examination of the daily weather maps, and the chart of average pressure and of prevailing wind directions for May 1917 (XLV—49) shows a preponderance of high atmospheric pressure to the north of the upper Lakes, and of low pressure over the northeastern districts, due to the frequent passage of storm areas moving from the southwestern States directly across New England. The winds over the districts from the Rocky Mountains eastward, were therefore largely from some northerly direction, and they carried with them the lower temperatures of the higher latitudes. Under normal conditions the prevailing winds are southerly over large areas of the eastern two-thirds of the country for the month of May, and carry with them the higher temperatures of the South. These conditions were largely reversed during May of the present year and cool northerly winds prevailed far south of their usual limits. This condition was particularly noted in portions of the Mississippi Valley and to the eastward.

The pressure distribution and wind directions were not, however, the only factors tending to lower the temperature. From the Ohio Valley northeastward, there was a marked absence of sunshine and daytime temperatures were consequently greatly reduced. Over much of this region the mean daily maximum temperatures ranged from 6 to 10 degrees below the corresponding normals, while the departures of the mean daily minima were generally about half as great. Similar conditions prevailed in portions of the Rocky Mountains district where, partly on account of absence of sunshine, the mean daily temperature maxima were from 8 to 12 degrees below normal, while the mean minima departures were scarcely one-third as great. In the northern Plains States reverse conditions existed, and under the influence of clear skies and dry weather the maximum temperatures were actually higher than the normals, but the intense radiation at night, as a result of the dry and clear conditions of the atmosphere, caused the night temperatures to go sufficiently low to overbalance the daytime excess and give monthly means below normal.

Frosts not severe.

Despite the continued cold, extremely low temperatures were not of frequent occurrence, in fact at only one station, El Paso, Tex., did the minimum temperature for May reach a lower point than had been previously reported in that month. Lower minimum temperatures in May than reported this year have been rather frequent in the past. For example, at Columbus, Ohio, during the past 20 years, minimum temperatures as low as, or lower than, reported at that station during May, 1917, are of record in about one-half the years. Neither were frosts so severe as have occurred in the same month of other years, in fact the southern limit of killing frost during May, 1917, was far north of the limit attained in May of some preceding years.

Cool weather and rainfall.

Cool weather during May is, as a rule, accompanied by considerable precipitation, because barometric pressure conditions responsible for cool weather in this month are also such as to favor considerable rainfall. During May, 1917, however, large areas with rather marked cool weather, had also deficient precipitation. This was especially the case in the northern border States from the Lakes Region westward to and including the northern portion of Montana. In this area rainfall during the month was unusually light, large areas receiving less than a tenth of an inch. Rainfall was likewise light, or negligible, over considerable areas in the Atlantic and Gulf States, especially the latter. In the principal corn belt, however, the month was nearly everywhere wetter than usual, which was also the case in some districts west of the Rocky Mountains.

Effects of low temperature.

While low temperatures retarded the planting and germination of corn, cotton, and other spring crops, and delayed the growth of gardens and truck over the southern districts, the cool weather was not unfavorable to winter wheat and other hardy cereals which are reported to have greatly improved during the month. Likewise fruit buds which had largely remained dormant escaped damage from the prevailing cold, although severe frosts were not experienced as late in the month as in some previous years. However, the cool weather was unfavorable in that it caused crops generally to be backward, which at the end of May were estimated to be from one to three weeks late throughout the country. This increases the liability to damage by fall frost for such crops as have a long period of growth.

In the upper Lakes region the continued cool weather greatly retarded the breaking up and melting of the ice, especially in Lake Superior, and over the northern straits. Prevailing northerly winds forced the ice toward the southern shores and much difficulty was experienced in moving the large amount of freight that had accumulated at the Soo Canal. At the end of May boats were still held in the ice at Duluth, the harbor at Marquette was completely closed and not a vessel could move through the ice fields. At Sault Ste. Marie navigation was greatly delayed and much loss to transportation interests resulted. It is stated that not for many years has ice in the Lake Superior region hindered navigation so late in the season. As an indication of the serious interruption to traffic, the report of the general superintendent on lake commerce through the canals at Sault Ste. Marie shows that the tonnage passing through the canals during April and May of the present year was less than 65 per cent of the amount carried in these months during the preceding year, despite the probable greatly increased demands for transportation.

Press dispatches as late as June 6 stated that the harbor at Duluth was at that time tightly icebound and that a number of vessels had been caught in a solid field of ice about half a mile outside the harbor.

TEMPERATURE CONDITIONS PRECEDING THIS COOL SPRING.

East of the Rocky Mountains, except in Montana, temperature conditions for the last year or more have presented no unusual features, there being no noteworthy departures from the normal for any period of considerable length. However, in Montana and from the Rocky Mountains westward the 13 months from May, 1916, to May, 1917, inclusive, were remarkable in that the temperature remained persistently, and in some cases decidedly, below the normal except in limited areas for a few of the months. In the central portion of the Plateau region conditions were specially remarkable during this period, each of the 13 months showing negative departures. At Winnemucca, Nev., the temperature

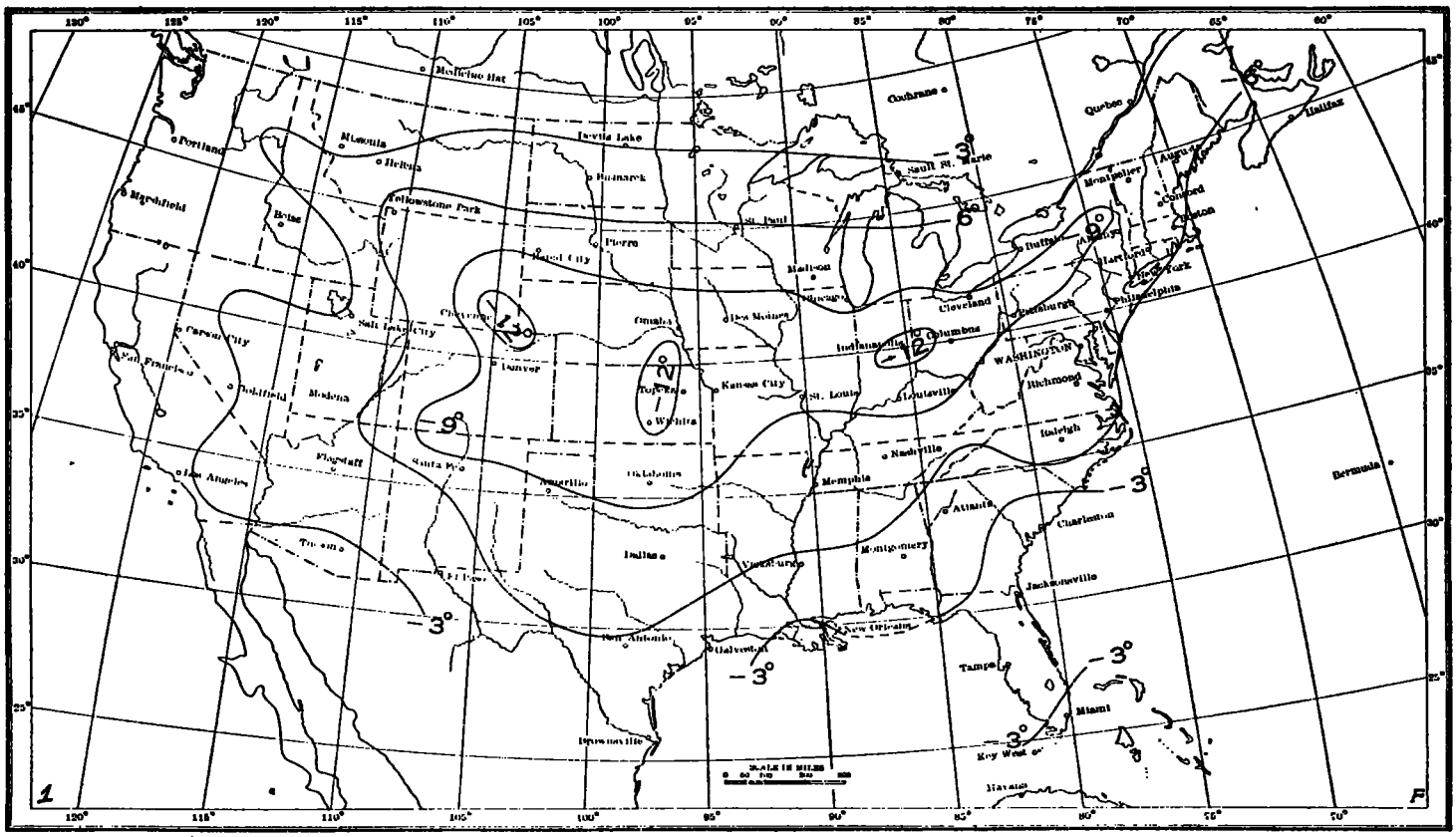

FIG. 1.—Map of mean temperature departures from the normals for the 21 days April 24–May 15, 1917. (°F.)

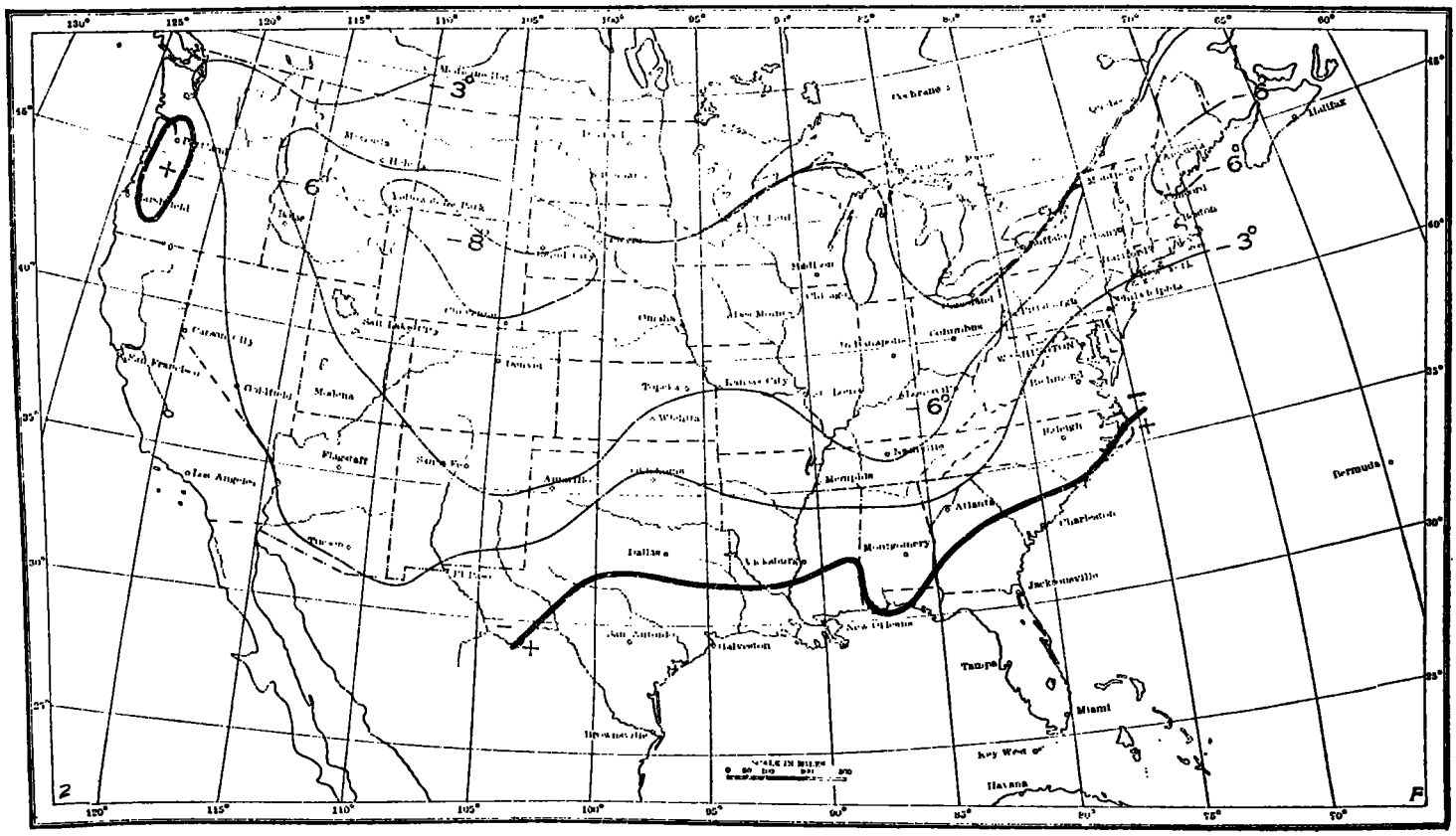

FIG. 2.—Map of mean temperature departures from the normals for the 28 days May 22–June 19, 1917. (°F.)

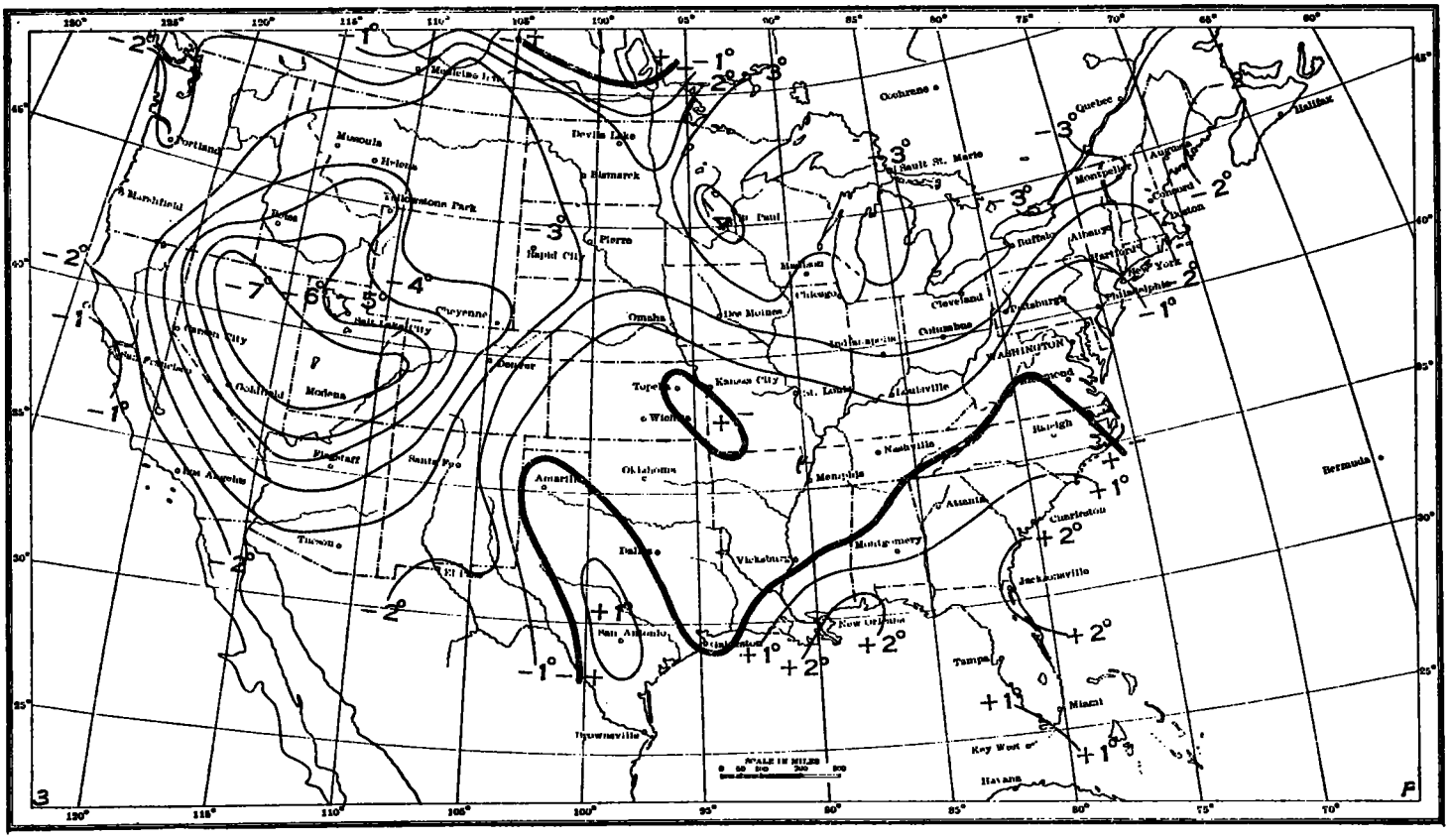

FIG. 3.—Map of mean temperature departures from the normals for the 151 days January 1–May 31, 1917. (°F.)

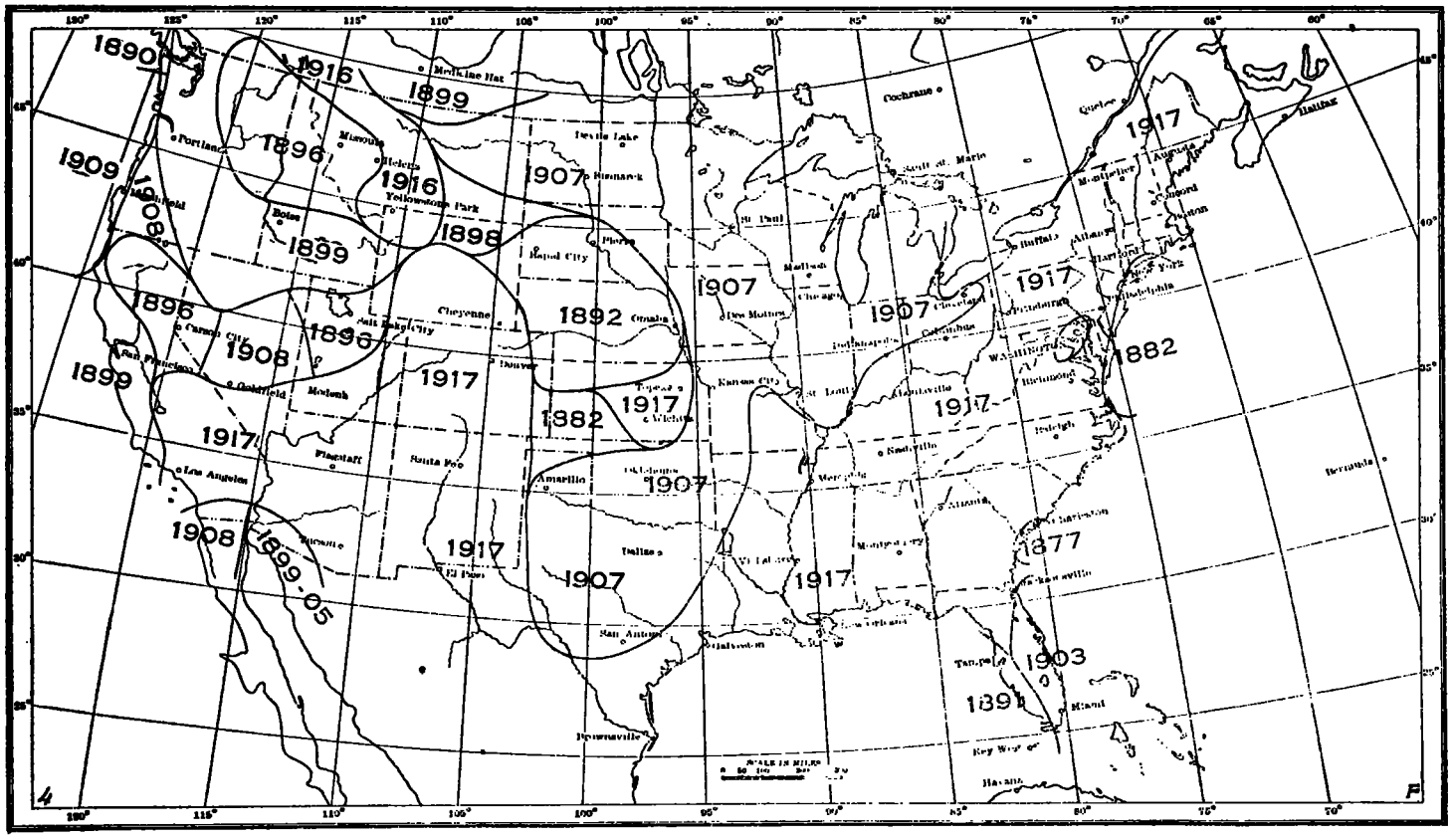

FIG. 4.—Map indicating the years showing the lowest mean temperature for May, and the areas affected. 1877–1917.

averaged about 4.5 degrees per day below the normal for the 400 days prior to June 1, 1917, while for the 5 months from January to May, 1917, the average deficiency was about 7 degrees per day. From January 8 to 26, 1917, a period of 19 days, the mean daily temperature at Winnemucca was only 5.3° F., or 23 degrees per day below the normal. The temperature departures from the normal for different sections of the country from January to May, 1917, inclusive, are shown in figure 3.

Subnormal temperatures persisted in all or portions of Montana also during 8 months of 1916 and for each of the 5 months from January to May, 1917. The temperature in the northern portion of that State for the 17 months January, 1916, to May, 1917, inclusive, averaged 4 degrees per day below the normal. At times during this period Montana experienced extremely low temperatures. From January 2 to February 12, 1916, a period of 42 days, the daily mean at Havre was about −12°F., or 26 degrees per day below the normal. During December of the same year there was another, but shorter, period of extremely cold weather recorded at this station when for 11 days the temperature averaged −14°F., or 32 degrees per day below the normal.

Lowest mean May temperatures.

Figure 4 shows the years in which the lowest mean May temperatures of record occurred and the areas affected, as revealed by records for about 45 years. It will be noted by referring to this chart that 1917 had the lowest mean May temperatures of record for a larger area than any other year in which low records were established in this month. The area covered in 1917 embraces practically the whole of the New England, Atlantic, and Gulf States, the eastern Lakes Region, Ohio Valley, Tennessee, and the middle Mississippi Valley. Likewise the middle and southern Rocky Mountains region, Arizona, portions of Utah, Nevada, and California had, on the whole, the coldest May since extensive temperature records have been maintained.

The year 1907 was that in which the lowest mean May temperatures of record occurred over the next largest area. The low records established in May of that year, cover much of Texas, Oklahoma, Arkansas and Missouri, the upper Mississippi Valley, and also most of the Lake region and the northern border States westward to Montana. However, in considerable portions of the area in which low May records were established in 1917, the monthly means were only slightly lower than those recorded in 1907.

In sections of the country in which the lowest mean May temperature occurred in years other than 1907 and 1917, the areas affected in individual years were comparatively small and the cool conditions were more largely the result of local causes. In most of South Dakota, in Nebraska, and in the northern portion of Kansas, the lowest mean May temperatures of record occurred in 1892, while in much of the northern Rocky Mountain and central and northern Plateau districts the lowest records were made in 1896 or 1899.

COLD WEATHER IN EUROPE DURING THE WINTER AND EARLY SPRING OF 1917.

While temperature conditions in the United States east of the Rocky Mountains, during the past winter and up to and including the most of April were not unusual, reports from Europe indicate that this period was characterized by severely cold weather and heavy snowfall. Unseasonably cold weather is reported to have set in over Europe toward the close of November, 1916, and continued till near the close of April, 1917. In London the temperature for the five months, December, 1916, to April, 1917, inclusive, averaged nearly 4 degrees below the normal, this being very unusual for a place whose climate is largely of the marine type. Information from western and northern Europe indicates that the continent was similarly affected with prolonged cold. However, about the time the period of cold weather set in over the central and eastern portions of the United States, the last decade in April, the persistent cold in Europe gave way to much warmer weather, and the month of May was rather remarkable for unseasonably high temperatures.[1]

OTHER COLD SPRINGS.

With respect to cold springs and summers, the year 1816 stands out as the most memorable for persistent cold weather and damage to vegetation, not only in this country, but in most of Europe also. This is known in the United States as "the year without a summer," and in Europe as "the famine year." From the information at hand there is no doubt that the year 1816 was a most disastrous one for agricultural interests. In it there culminated a remarkable depression of summer temperatures which began with the summer of 1811 and continued till 1817. In portions of the Central and Northern States snow or frost appears to have occurred in every month of 1812 and 1816, and well-authenticated reports of loss of life by cold in the summer of the latter year are on record. Fruits and grains, especially corn, either partially or wholly failed to mature, resulting in a scarcity of food not known since that time.

The year 1859 was also remarkable for the cold weather experienced during the late spring or early summer. In that year, about June 5, severe cold weather for the season occurred in the Middle and North Atlantic States and Ohio Valley, temperatures several degrees below freezing being reported from many places, and freezing weather was general in western Pennsylvania and northern Ohio. Ice 2 inches thick was reported from Johnstown, Pa.

In 1882 May was remarkably cold for the season in the districts east of the Rocky Mountains, the mean temperatures for that month at many places being only 1 or 2 degrees higher than the lowest of record for May.

May, 1907, stands next to 1917 as a month of unusual cold, as has been noted previously, but despite the low temperatures staple crops were not materially reduced in yield. Likewise in May, 1910, there was a general and large deficiency in temperature in central and eastern districts.

SOME ASPECTS OF THE COLD PERIOD, DECEMBER, 1916, TO APRIL, 1917.

[Nature, London, June 28, 1917, 99: 359.]

R. C. Mossman presented, at the June 20 meeting of the Royal Meteorological Society, remarks on this subject. In the course of his remarks the author said that the mean temperature of the British Isles during the period under notice, taking the means of the 12 divisions used in the Monthly Weather Reports of the Meteorological Office, was 1.9 degrees C. below normal, the extremes ranging from 2.8 degrees below normal at

[1] In this connection see following abstract of address by R. C. Mossman as published in Nature, June 28, 1917.—*Editor.*